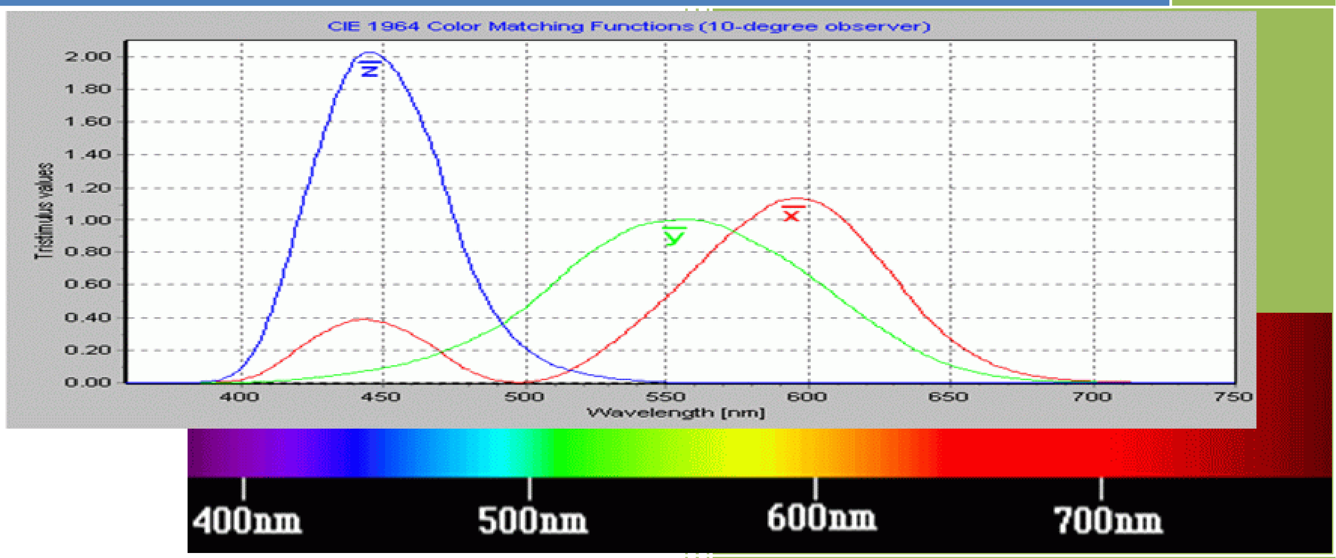
2014

Chroma Meter Detail/Notes



Optical Applications

Intersil

11/14/2014

1 ISL29125 Evaluation Board Calibration Procedure

1.1 Connect ISL29125 evaluation board to the PC/Laptop via µUSB cable

1.2 Launch "Chroma meter"

1. Open EEprom GUI by clicking on "CCM" on the left top corner ①

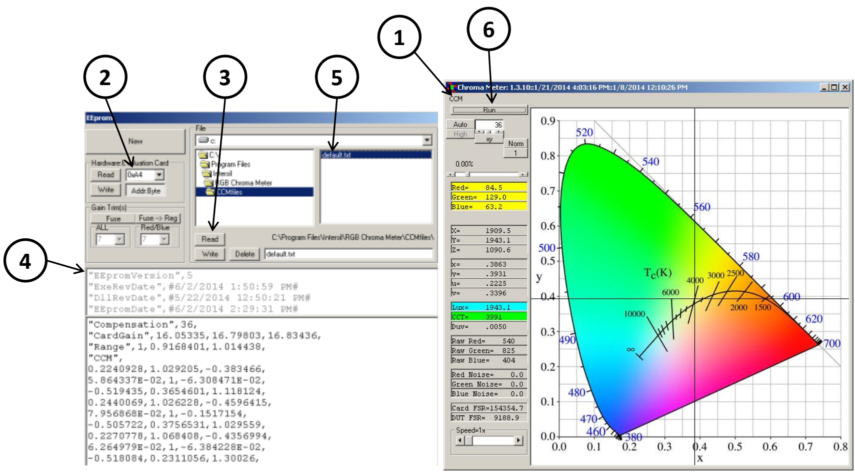


Figure 1 Chroma Meter GUI and related EEprom GUI

2. Set I2C address to 0xA4 for Evaluation card as shown in 0.②
3. Click on "Read" to read out the calibration data from EEprom.③

   The latest EEprom calibration data version should be 5 ④ if not, import the calibration header text from “default.txt” ⑤ as shown in the rightmost panel under installation directory by pressing Read button.

   “C:\Program Files\Intersil\RGB Chroma Meter\CCMfiles”

   Note above directory may be changed depending on the installation directory of Chroma meter

4. Click on 'Run' button so that it changes to 'hold' before Calibration in excel.⑥

1.3 Launch "simple.ALS.drv.xlsm"

Go to Tab “EVB CCT Cal”. Hit "Reset" button ① to clear the historical calibration data including the calibration data section (green part) ②, IR compensation and Measured XYZ values (yellow sections) ③.

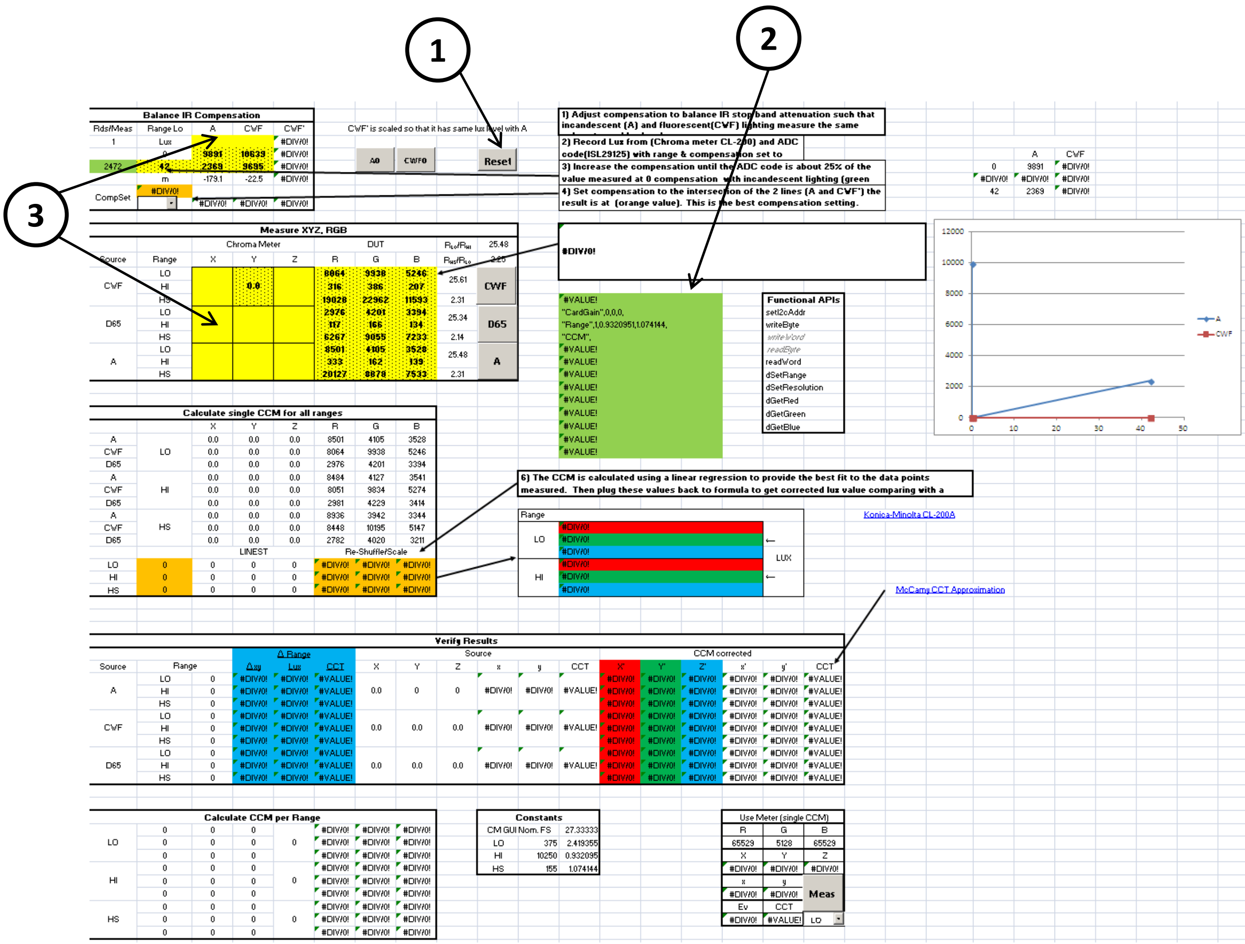


Figure 2 Calibration Spreadsheet

1.4 Perform IR compensation calibration

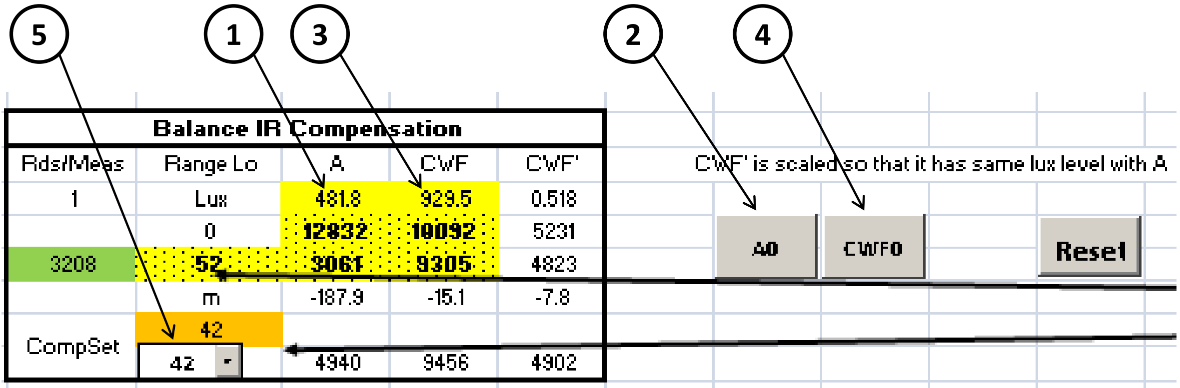


Figure 3 IR compensation section

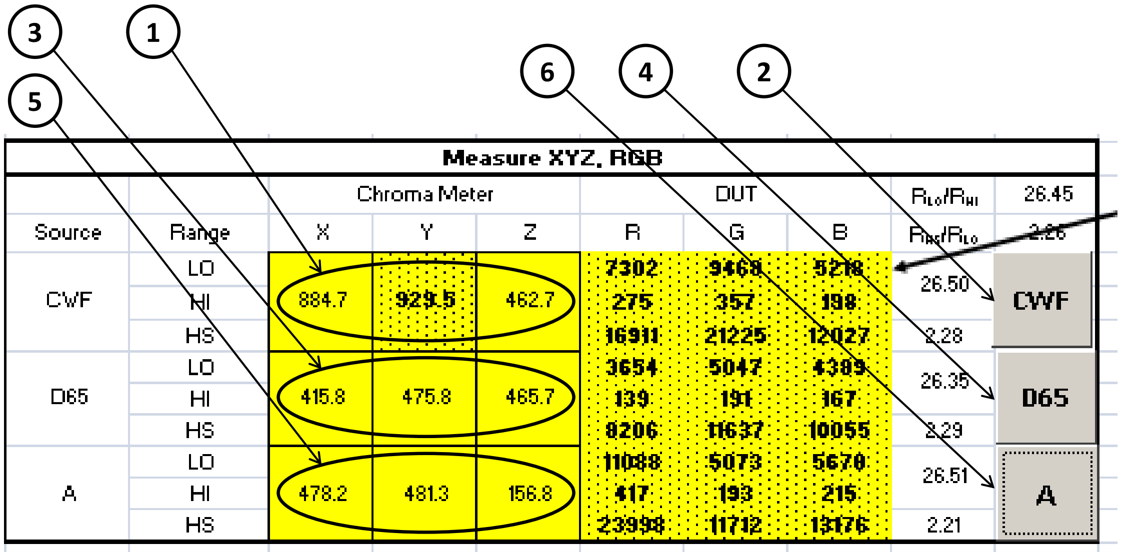
1.4.1 Measure A luminance lux (EV value)

1. Turn on 3200K/8000 lux light source (Quartz Tungsten Halogen (QTH) lamps).
2. Place the color conversion filter (D30 to A) between the QTH light source and the Integrated sphere to generate the A illuminant (CCT~2800K)
3. Input the chroma meter reading of A illuminant light level (lux) value. ①
4. Press the button “A0”. ②

1.4.2 Measure CWF luminance lux (EV value)

1. Turn on 3200K/8000 lux light source (Quartz Tungsten Halogen (QTH) lamps).
2. Place the color filter (D30 to CWF) between the light source and the integrated sphere to generate CWF illuminant (CCT ~4000K)
3. Input the chroma meter reading of CWF illuminant light level (lux) value. ③
4. Press the button “CWF0”. ④ The IR compensation values can be found to the right side of CompSet. ⑤

1.5 Perform CCM calibration



Measure XYZ, RGB									
		Chroma Meter			DUT			R_{LO}/R_{HI}	26.45
Source	Range	X	Y	Z	R	G	B	R_{HS}/R_{LO}	2.26
CWF	LO				7302	9468	5218	26.50	CWF
	HI	884.7	929.5	462.7	275	357	198		
	HS				16911	21225	12027	2.28	
D65	LO				3654	5047	4389	26.35	D65
	HI	415.8	475.8	465.7	139	191	167		
	HS				8206	11637	10055	2.29	
A	LO				11088	5073	5670	26.51	A
	HI	478.2	481.3	156.8	417	193	215		
	HS				23998	11712	13176	2.21	

Figure 4 XYZ calibration section

1.5.1 Measure CWF illuminant tristimulus values (XYZ)

1. Turn on 3200K/8000 lux light source (Quartz Tungsten Halogen (QTH) lamps).
2. Place the color filter (D30 to CWF) between the light source and the integrating sphere to generate the CWF illuminant (CCT 4000K)
3. Input the chroma meter reading of XYZ values into the CWF Cells ① in tab “EVB CCT Cal” and Press button “CWF”. ②

1.5.2 Measure D65 illuminant tristimulus values (XYZ)

1. Turn on 3200K/8000 lux light source (Quartz Tungsten Halogen (QTH) lamps).
2. Place the color filter (D30 to D65) between the light source and the integrating sphere to generate the CWF illuminant (CCT 6500K)
3. Input the chrome meter reading of XYZ values into the D65 Cells ③ in tab “EVB CCT Cal and Press button “D65”. ④

1.5.3 Measure A illuminant tristimulus values (XYZ)

1. Turn on 3200K/8000 lux light source (Quartz Tungsten Halogen (QTH) lamps).
2. Place the color filter (D30 to A) between the light source and the integrating sphere to generate the CWF illuminant (CCT~2800K)
3. Input the chrome meter reading of XYZ values into the A Cells ⑤ in tab “EVB CCT Cal” and Press button “A”. ⑥

1.6 Copy the generated CCM calibration value, CardGain, CCM and Range from green cells ① and paste it into Chroma meter EEprom data region ② and press “Write” button in the upper left corner. ③

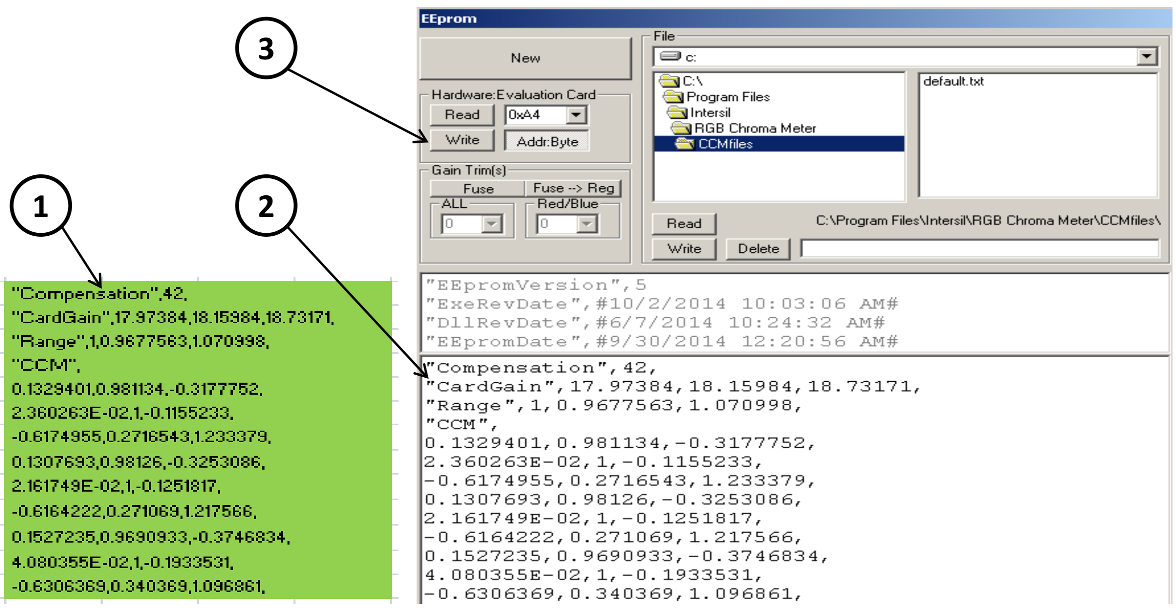


Figure 5 Final Calibration Write into EEprom

2 Measuring IR/Clear

The ISL29125 has the capability of indirectly measuring the near IR content within the bandwidth of silicon photo diodes. This section will detail how this measurement technique can be performed.

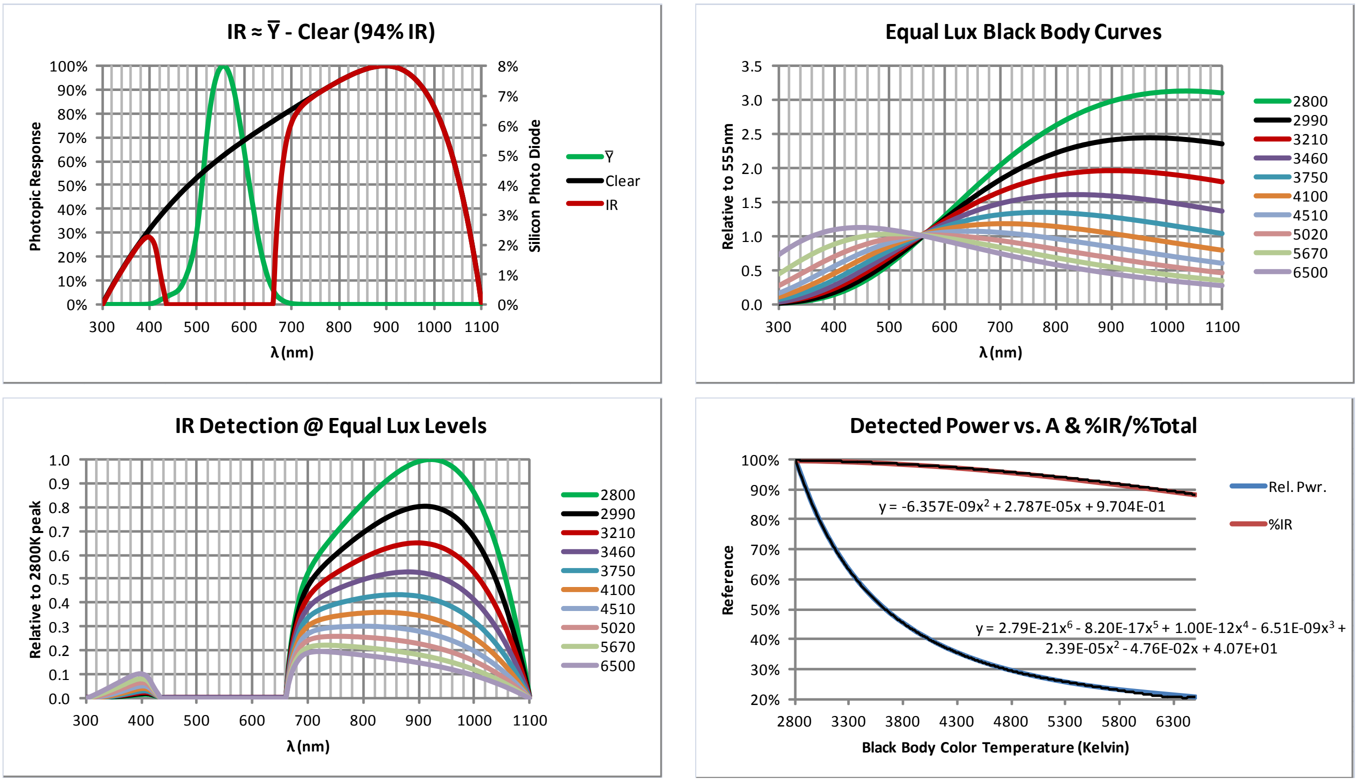
2.1 Theory of Operation

The Green channel of the `125 RGB differs from the Red and Blue channel in that the design has features which help it perform the Lux / Y measurement independent from the other channels over a wider range of glass spectra (namely IR pass glass used for proximity sensing devices). The Red and Blue channels consist of color coated photo diodes combined with a short pass dielectric filter used to reduce IR energy. The Green channel combines a photo diode, a dielectric band-bass filter and an adjustable IR compensation. The IR compensation subtracts a variable amount energy detected by an uncoated diode from that of the filtered diode. Since the response of a silicon photo diode is higher in the IR region than in the visible region then the majority of the power of broadband (black body) source measured is IR. Can derive the “IR” detected by applying information we have measured with the system we are calibrating/characterizing as discussed in §1.4 to subtract the visible component from the uncoated diode.

Figure 6 ISL29125 Diode/Compensation Architecture

Figure Here

Figure 7 Detected Power = ∫ (Spectral Response x Input Spectrum)



2.2 Algorithm

The comparison of two measurements of the same power light source at different compensation settings is enough to measure the %/power (relative to visible lighting) in the IR region between visible & the limit of the silicon photodiode (~1.1µm). The higher the compensation setting the lower the detected power is measured by the RGB. The relationship is linear and inversely proportional. The higher the IR content is in the source the steeper the slope is for a given change in the compensation value. Following the definitions in **Error! Reference source not found.**:

Equation 1 %IR Calculation

$$\Delta Total = CompMeas_{HI} - CompMeas_{LO} \quad (1)$$

$$\Delta IR = \Delta Total - \Delta Visible \quad (2)$$

$$VisibleAdj = (\, Visible/Tick \approx -0.17\% \,) * (\, CompSet_{HI} - CompSet_{LO} \,) \quad (3)$$

$$\Delta Visible = CompMeas_{LO} * VisibleAdj \quad (4)$$

$$\Delta IR = CompMeas_{HI} - CompMeas_{LO} * (\, 1 + VisibleAdj \,) \quad (5)$$

1. ΔTotal: is the total change in the detected value between the two compensation settings
2. ΔIR: is equal to the total change minus the change do to visible lighting alone.
3. VisibleAdj: is what % of the measured value has changed from the visible content. This value should be near 0.15% for the system measured in §1.4.
4. ΔVisible: is the amount of the change in the value do to visible lighting.
5. ΔIR: solved in terms of the values measured values combined with calibration/characterization values of the system.

Note that for a given light source ΔIR/ΔTotal should remain constant. If a significant color temperature change has not been detected then the IR content of the light will remain proportional to the visible content. Since this is true then there is no reason to repeatedly toggle the compensation setting to measure the IR unless a significant color temperature change (i.e. > 20%/value) has be detected.

2.3 Pseudo code

Example code is shown in Figure 8.

Figure 8 Pseudo code

```
initialization:
        // values defined in §1.4

        compSet = X

        if |X| > 0 then
                Δcomp = 0
        else
                Δcomp = 10
        end if

        visibleAdjust = 0.15%

return

mainLoop:
        :
        measureRGB
        lastGreen = green
        :
        :
        if |ΔCCT| > 20% then
                measureIRratio
        else
                irValue = irRatio * green
        end if
return

measureIRratio:
        setToGreenOnly
        setCompToDeltaComp
        waitUntilConversionDone
        getGreenValue

        if compSet > 0 then // Δcomp is = 0 (higher power detected)
                ΔIR = green - lastGreen * (1 + visibleAdjust)
        else
                ΔIR = lastGreen - green * (1 + visibleAdjust)
        end if

        irRatio = ΔIR/lastGreen

return
```

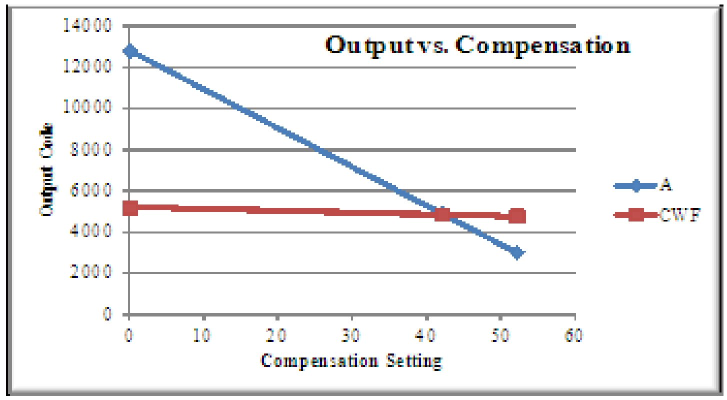
2.4 Example

The

Table 1 Example Calibration Values

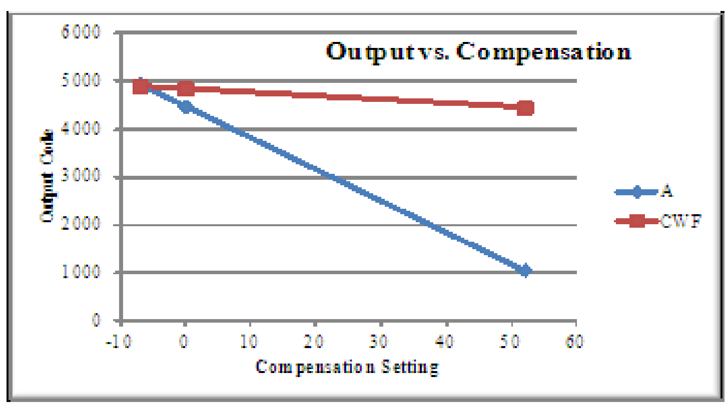
Positive Compensation

	B	C	D	E
2	Device Output Measured @ 500Lux			
3	Compensation Setting	A	CWF	IR A - CWF
4	0	12830	5230	
5	52	3060	4800	
6	m	-187.9	-8.3	-179.6
7	%/VALUEcomp	-3.80%	-0.17%	-3.63%
8	Final calculated compensation value			
9	42	4939	4883	-7.11%
10	IR	7540	-25	
11	Range Visible FSR	6673	A %IR	60.4%



Negative Compensation

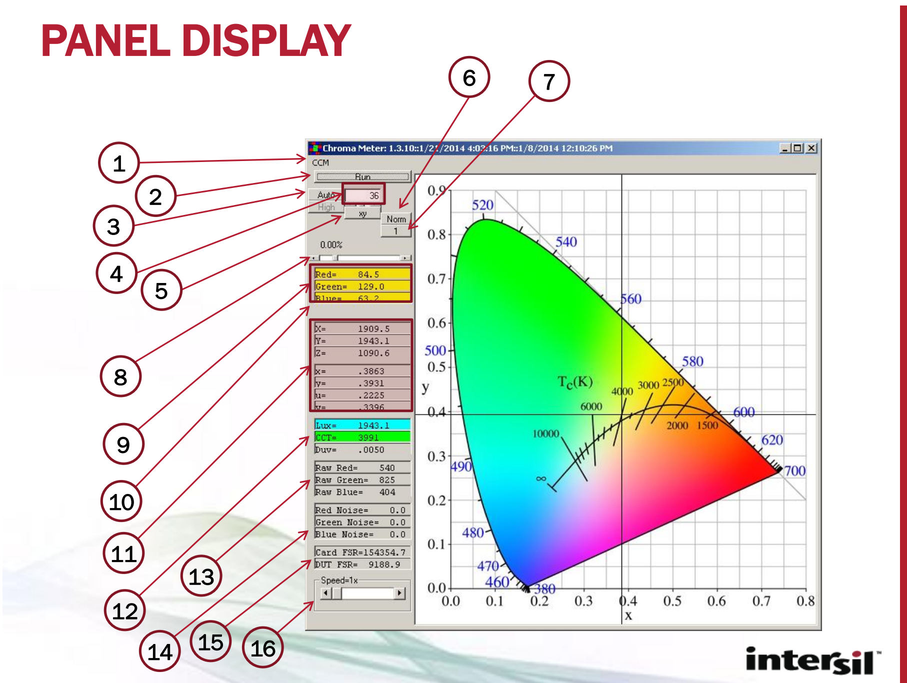
	B	C	D	E
2	Device Output Measured @ 500Lux			
3	Compensation Setting	A	CWF	IR A - CWF
4	0	4475	4851	
5	52	1062	4448	
6	m	-65.6	-7.8	-57.9
7	%/VALUEcomp	-1.33%	-0.16%	-1.17%
8	Final calculated compensation value			
9	-7	4935	4905	-1.11%
10	IR	410	0	
11	Range Visible FSR	6660	A %IR	7.7%



3 Addenda

3.1 GUI Widgets

Figure 9 Main Panel Widgets



PANEL DISPLAY

1. CCM: allows to load new coefficients if users have a custom system setup
2. Run button: by default sensor will run continuously. When pressed, data will be held at the last value.
3. Auto button: Auto ranges from range0 to range1 or once it is toggled to "Fixed" Then sensor can do single range depending on user selection.
4. xy button: shows Planckian locus graph in xy coordinate system on the right hand side (colored graph) or once it is toggled, then uv-coordinates will be displayed (colored graph).
5. Compensation: Scroll-bar allows user to set compensation value for sensor under different light sources. Display window shows compensation value. Range is between 0-127.
6. Selects between normal and maximum high sensitivity on the low range only.
7. Enables 32 sample averaging
8. Allows user to change absolute gain of corrected lux value to match the Lux Meter (CL-200 or T-10) . The absolute gain can be changed to +/-500%.
9. Raw data of Red, Green and Blue read from ISL29125 in percentage of full scale per range.
10. dIR: percentage IR value changes relative to full scale from compensation=0. The higher IR value in the display window means sensor is under stronger IR-content lamp.
11. XYZ displays show corrected value Lux value which transfers from raw RGB to XYZ. xy/uv displays show corrected xy /uv coordinate system of sensor to Planckian locus
12. Lux Display shows corrected lux which has been transformed = Y. CCT displays shows color temperature of light source.
13. Raw ADC output code
14. RMS noise of raw RGB values in %/value
15. Card/DUT FSR: Full scale (in Lux) of the evaluation card and the sensor (internal to the card)
16. Speed: Let's the user select the number of ADC bits and the speed of the conversion.

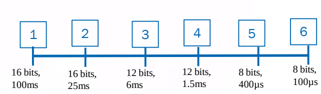
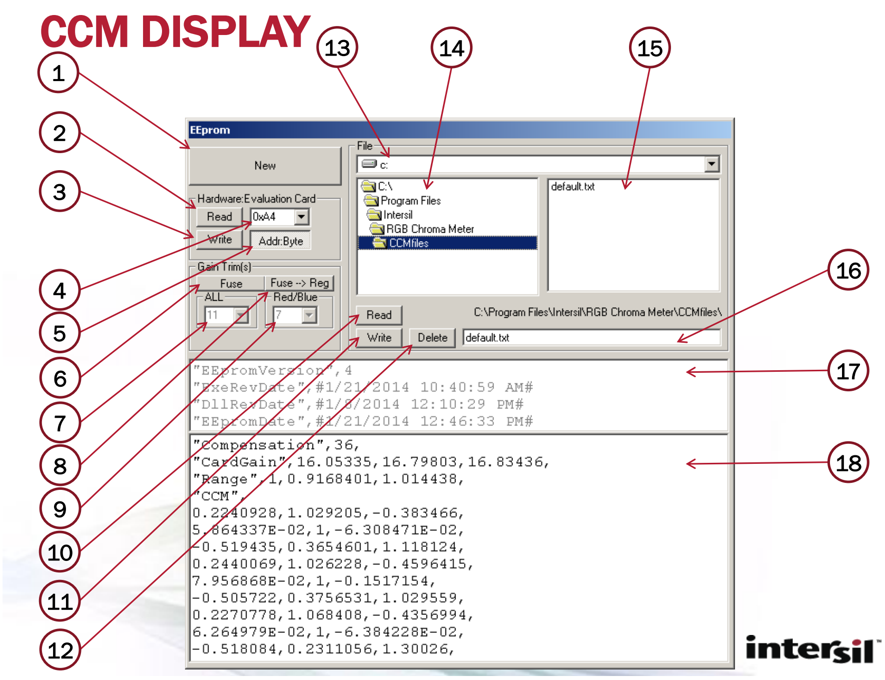


Figure 10 EEprom Widgets



CCM DISPLAY

1. New
2. Hardware Read
3. Hardware Write
4. Address Select
5. Byte/Word Address mode
6. Fuse/Reg Select
7. Fuse Trim MSB nibble (ALL – Coarse) ±22.5% (3% resolution)
8. Copy Fuse set to Reg
9. Fuse Trim LSB nibble (Fine – R&B only) ±6% (0.8% resolution)
10. File Read
11. File Write
12. File Delete
13. Drive select
14. Directory select
15. File Select
16. File display/edit
17. Header contents (read only)
18. Calibration values